

SIGNIFICANT POINTS

- Telecommunications are rapidly expanding beyond traditional voice telephone service.
- The demand for greater telecommunications capacity—or bandwidth—will create jobs that require technical skills.
- Average earnings in telecommunications greatly exceed average earnings throughout private industry.

Nature of the Industry

Changes in technology and government regulation continue to transform the telecommunications industry. Whereas voice telephone communication was once the primary service of the industry, the transmission of a variety of materials, including data, graphics, and video, is now commonplace. The widespread installation of fiber optic cables, which transmit light signals along glass strands, permits faster, higher capacity transmissions than those that are possible with traditional copper wirelines. In addition, networks of radio towers provide rapidly expanding wireless telecommunications services.

Changes in government regulation have introduced competition into an industry that was once dominated by a single company. Competition from outside the industry is increasing as cable companies and public utilities expand their own communications networks.

The principal sector of the telecommunications industry is telephone communications. Establishments in this sector operate both wireline and wireless networks. Wireline networks use wires and cables to connect customers' premises to central offices maintained by telecommunications companies. Central offices contain switching equipment that routes content to its final destination or to another switching center. For example, switching equipment may route local phone calls directly from the central office to their final destination; long distance calls are routed to larger switching centers that determine the most efficient route for the call to take.

Wireless networks are rapidly expanding; they operate through the transmission of signals over networks of radio towers. For example, a wireless cellular telephone transmits radio signals to an antenna located on a radio tower. The signal is then transmitted through the antenna into the wireline network. Other wireless services include beeper, paging, and limited Internet access. Because these devices require no wireline connection, they are popular with customers who need to communicate as they travel, residents of areas with inadequate wireline service, and those who simply desire the convenience of portable communications.

Wireless providers are developing additional technology called third generation (3G) wireless access. Conventional wireless Internet access is slow, and allows cellular phones to display only limited amounts of text-based information. A 3G system allows high-speed data transmission and better Internet access. Wireless service is expanding into homes through fixed cellular service, which involves connecting the telephone system in a house to an antenna, instead of a telephone line. It should become increasingly common, because 3G wireless will provide a level of service similar to that of wireline systems.

The wireline and wireless sectors also include resellers of telecommunications services who compete with traditional local telephone service providers. These resellers lease transmission facilities, such as telephone wirelines, from existing telecommunications networks, and then resell the service to other customers. Other sectors in the industry include message communications services, such as e-mail and facsimile services, and operators of other communication services, ranging from radar stations to radio networks used by taxicab companies.

Voice telephone communications have long been the predominant service offered by telephone companies. With the rising popularity of the Internet, however, customers increasingly use their telephone service to transmit data and other electronic materials. The transmission of such content relies on digital technologies that use telecommunications networks more efficiently than do conventional systems. Digital signals consist of separate pieces of electronic code that can be broken apart during transmission and then reassembled at the destination without loss of clarity. Telecommunications providers have built networks of computerized switching equipment, called packet switched networks, to route digital signals. Packet switches break the signals into small segments or "packets" and provide each with the necessary routing information. Segments may take separate paths to their destination and may share the paths with transmissions from other users. At the destination, the segments are reassembled, and the transmission is complete. Because packet switching considers alternate routes, and allows multiple transmissions to share the same route, it results in a more efficient use of telecommunications capacity.

The transmission of voice signals requires relatively small amounts of capacity on telecommunications networks. By contrast, the transmission of data, video, and graphics requires much higher capacity. This transmission capacity is referred to as bandwidth. As the demand increases for high-capacity transmissions—especially with the rising volume of Internet data—telecommunications companies are continually expanding and upgrading their networks to increase the amount of available bandwidth.

Wireline providers are expanding their networks by laying additional fiber optic cable, which provides higher bandwidth and transmission speed than does copper wire. The capacity of fiber optic cables is increasing due to a technology known as wavelength division multiplexing (WDM). WDM divides each glass strand within a cable into different colors of the spectrum; each color can carry a separate stream of data, increasing overall capacity. Providers have also begun offering upgraded service on the copper wirelines that connect most residential customers with the central offices. Technologies such as digital

subscriber lines (DSL) allow simultaneous transmission of voice and data communications at relatively high speeds. Additionally, satellite communications providers are expanding a network of satellites that competes with wireline providers for high-bandwidth data communication services.

The Telecommunications Act of 1996 allowed competition in all sectors of the communications industry, from local and long-distance telephone services to cable television and broadcasting. The Act also opened the telecommunications market to sectors outside the industry, such as public utilities. As a result of this latest round of industry deregulation, telecommunications companies are able to compete across traditionally separate markets. For example, a single provider might offer both local and long-distance telephone service. Providers from other industries also are entering the telecommunications market, offering cable TV and high-speed Internet access, as well as telephone service. Such convergent services are popular with customers seeking to consolidate their purchase of communication services. To meet this demand for combined services, mergers are taking place as companies seek to acquire the services they need to compete in the marketplace.

Working Conditions

The telecommunications industry offers steady, year-round employment. Overtime sometimes is required, especially during emergencies such as floods or hurricanes when workers may need to report to work with little notice.

Telecommunications line installers and repairers work in a variety of places, both indoors and outdoors, and in all kinds of weather. Their work involves lifting, climbing, reaching, stooping, crouching, and crawling. They must work in high places such as rooftops and telephone poles, or below ground when working with buried lines. Their jobs bring them into proximity with electrical wires and circuits, so they must take precautions to avoid shocks. These workers must wear safety equipment when entering manholes, and test for the presence of gas before going underground.

Telecommunications equipment installers and repairers, except line installers, generally work indoors—most often in a telecommunication company's central office or a customer's place of business. They may have to stand for long periods; climb ladders; and do some reaching, stooping, and light lifting. Adherence to safety precautions is essential to guard against work injuries such as minor burns and electrical shock.

Most communications equipment operators, such as telephone operators, work at video display terminals in pleasant, well-lighted, air-conditioned surroundings. If the worksite is not well designed, however, operators may experience eye strain and back discomfort. The rapid pace of the job and close supervision may cause stress. Some workplaces have introduced innovative practices among their operators to reduce job-related stress.

The number of disabling injuries in telephone communications, the principal sector of the telecommunications industry, has been well below the average for all industries in past years. In 1999, cases of work-related injury and illness were 2.8 per 100 full-time workers, significantly lower than the 6.3 per 100 full-time workers for the entire private sector.

Employment

The telecommunications industry provided almost 1.2 million wage and salary jobs in 2000. Most jobs were concentrated in telephone communications. Only 34,000 worked in the other

sector of the telecommunications industry—telegraph and communications services, not elsewhere classified.

Most telephone employees work in large establishments. About 77 percent of employment is in establishments with 50 or more employees (chart). With continuing deregulation, however, the number of small contractors has been increasing. Telecommunications jobs are found in almost every community, but most telephone employees work in cities that have large concentrations of industrial and business establishments.

Occupations in the Industry

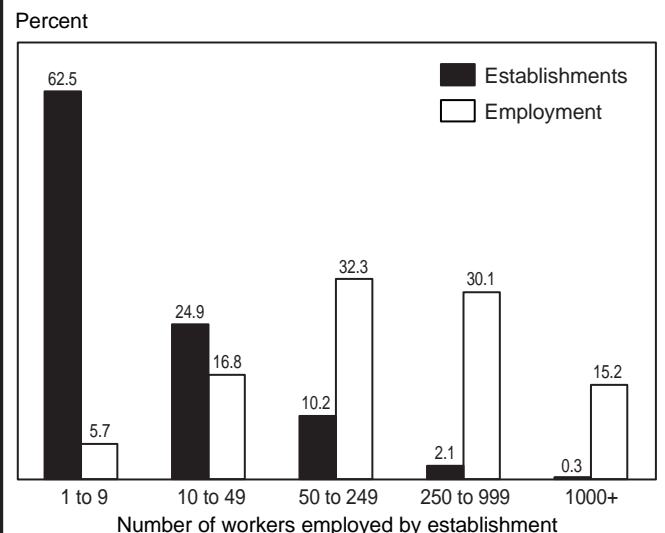
Although the telecommunications industry employs workers in many different occupations, about 55 percent of all workers are employed in either office and administrative support occupations or installation, maintenance, and repair occupations (table 1).

Telephone craftworkers install, repair, and maintain telephone equipment, cables and access lines, and telecommunications systems. These workers can be grouped by the type of work they perform. *Telecommunications line installers and repairers* connect telephone central offices to customers' telephone systems. They install poles and terminals, and place wires and cables that lead to a consumer's premises. They use power-driven equipment to dig holes and set telephone poles. Line installers climb the poles or use truck-mounted buckets (aerial work platforms) and attach the cables using various hand tools. After line installers place cables on poles, or towers or in underground conduits and trenches, they complete the line connections.

Telecommunications equipment installers and repairers, except line installers, install, repair, and maintain the array of increasingly complex and sophisticated communications equipment and cables. Their work includes setting up, rearranging, and removing the complex switching and dialing equipment used in central offices. They may also solve network-related problems and program equipment to provide special features.

Some telecommunications equipment installers are referred to as telephone station installers and repairers. They install, service, and repair telephone systems and other communications

Three out of 4 workers in telecommunications are employed at establishments with 50 or more workers



Source: U.S. Department of Commerce, *County Business Patterns*, 1997

Table 1. Employment of wage and salary workers in telecommunications by occupation, 2000 and projected change, 2000-10

(Employment in thousands)

Occupation	Employment, 2000		Percent change, 2000- 2010
	Number	Percent	
All occupations	1,168	100.0	12.2
Management, business, and financial occupations	235	20.2	15.8
Marketing and sales managers	11	1.0	30.6
Computer and information systems managers	9	0.7	48.0
General and operations managers	23	1.9	12.1
Human resources managers	10	0.8	8.9
Management analysts	19	1.6	16.9
Financial specialists	17	1.4	22.5
Professional and related occupations	137	11.7	33.3
Computer software engineers, systems software	15	1.3	60.4
Computer support specialists	14	1.2	77.9
Electrical and electronics engineers	8	0.7	15.6
Electrical and electronic engineering technicians	10	0.8	6.5
Sales and related occupations	143	12.3	14.3
Retail salespersons	11	0.9	18.8
Sales representatives, wholesale and manufacturing, technical and scientific products	33	2.9	14.6
Sales representatives, wholesale and manufacturing, except technical and scientific products	19	1.6	6.8
First-line supervisors/managers of non-retail sales workers	21	1.8	7.0
Telemarketers	9	0.8	18.9
Office and administrative support occupations	374	32.0	6.8
First-line supervisors/managers of office and administrative support workers	30	2.6	18.9
Telephone operators	41	3.5	-40.5
Bill and account collectors	8	0.7	12.4
Bookkeeping, accounting, and auditing clerks	10	0.8	2.2
Customer service representatives	141	12.1	22.7
Material recording, scheduling, dispatching, and distributing occupations	21	1.8	14.5
Office clerks, general	30	2.6	4.8
Executive secretaries and administrative assistants	13	1.1	6.7
Installation, maintenance, and repair occupations	265	22.7	4.7
First-line supervisors/managers of mechanics, installers, and repairers	18	1.5	18.9
Telecommunications equipment installers and repairers, except line installers	126	10.8	-4.9
Electrical power-line installers and repairers	10	0.9	18.9
Telecommunications line installers and repairers	68	5.8	10.1

NOTE: May not add to totals due to omission of occupations with small employment.

equipment on customers' property. When customers move or request new types of service, such as a high-speed internet connection, a fax, or an additional line, installers relocate telephones or make changes in existing equipment. They assemble equipment and install wiring. They also connect telephones to out-

side service wires and sometimes must climb poles or ladders to make these connections.

Telephone operators, including central office operators and directory assistance operators, make telephone connections; assist customers with specialized services such as reverse-charge calls; provide telephone numbers; and may provide emergency assistance.

Customer service representatives help customers understand the new and varied types of services offered by telecommunications providers. Some customer service representatives also are expected to sell services and may work on a commission basis. Other administrative support workers include *financial, information, and records clerks; secretaries and administrative assistants; and first-line supervisors/managers of office and administrative support workers*. These workers perform a variety of duties including keeping service records, compiling and sending bills to customers, and preparing statistical and other company reports.

About 12 percent of the industry's employees are professional workers. Many of these are scientific and technical personnel such as engineers and computer specialists. *Engineers* plan cable and microwave routes, central office and PBX equipment installations, and the expansion of existing structures, and solve other engineering problems. Some engineers also engage in research and development of new equipment. Specializing in telecommunications design voice and data communications systems, and integrate communications equipment with computer networks. They work closely with clients, who may not understand sophisticated communications systems, and design systems that meet their customers' needs. *Computer software engineers and network systems and data communications analysts* design, develop, test, and debug software products. These include computer-assisted engineering programs for schematic cabling projects; modeling programs for cellular and satellite systems; and programs for telephone options, such as voice mail, electronic mail, and call waiting. Telecommunications specialists coordinate the installation of these systems and may provide follow-up maintenance and training. In addition, the industry employs many other managerial, professional, and technical workers, such as *financial information and record clerks; accountants and auditors; human resources, training, and labor relations managers; engineering technicians; and computer programmers*.

About 12 percent of the industry's employees are in sales and related occupations. These workers sell telecommunications services, such as long-distance service, personal answering services, voice mail, electronic mail, and call-waiting telephone options.

New occupational specialties have emerged based on the industry's new innovations and technologies. For example, some engineers research, design, and develop gas lasers and related equipment needed to send messages via fiber optic cable transmission. They study the limitations and uses of lasers and fiber optics; find new applications for them; and oversee the building, testing, and operations of the new applications.

Training and Advancement

The telecommunications industry offers employment in jobs requiring a variety of skills and training. Many jobs require a high school education in addition to on-the-job training. Other jobs require particular skills that may take several years of experience to learn completely. For some managerial and professional jobs, employers require a college education.

Line installers often are hired initially as helpers, ground workers, or tree trimmers who clear branches from telephone lines. Because the work entails a lot of climbing, applicants should have physical stamina and be unafraid of heights. The ability to distinguish colors is necessary because wires and cables are coded by color. Although line installers usually do not complete a formal apprenticeship, they generally receive several years of on-the-job training. Line installers may transfer to other highly skilled jobs, such as engineering assistant, or may move into other kinds of work, such as sales. Promotion to crew supervisor, technical staff, or instructor of new employees also is possible.

Most companies prefer to hire telecommunications equipment installers and repairers with postsecondary training in electronics; familiarity with computers is also important. Training sources include 2- and 4- year college programs in electronics or communications, trade schools, and training provided by equipment and software manufacturers. Telecommunications equipment installers and repairers may advance to jobs maintaining more sophisticated equipment or to engineering technician positions.

Communications equipment operators should have clear speech and good hearing; computer literacy and typing skills also are important. New operators learn equipment operation and procedures for maximizing efficiency. Instructors monitor both the time and quality of trainees' responses to customer requests. Formal classroom instruction and on-the-job training may last several weeks.

A bachelor's degree in engineering usually is required for entry-level jobs as electrical and electronics engineers. Continuing education is important for these engineers; those who fail to keep up with the rapid changes in technology risk technological obsolescence, which makes them more susceptible to layoffs or, at a minimum, more likely to be passed over for advancement.

While there is no universally accepted way to prepare for a job as a computer professional, most employers place a premium on some formal college education. Computer software engineers usually hold a degree in computer science or in software engineering. For systems analyst, computer scientist, or database administrator positions, many employers seek applicants who have a bachelor's degree in computer science, information science, or management information systems.

Due to the rapid introduction of new technologies and services, the telecommunications industry is among the most rapidly changing in the economy. This means workers must keep their job skills up to date. From managers to telephone operators, increased knowledge of both computer hardware and software is of paramount importance. Several major companies and the telecommunications unions have created a website that provides free training for current employees, enabling them to keep their knowledge current and helping them to advance. Telecommunications industry employers now look for workers with skills, abilities, and knowledge in the following areas: computer programming and software design; voice telephone technology, known as telephony; laser and fiber optic technology; wireless technology; data compression skills; and sales ability enhanced by interpersonal skills and a knowledge of telecommunications terminology.

Earnings

Average weekly earnings of nonsupervisory workers in telephone communications, the principal sector of the telecommunications

industry, were \$743 in 2000, significantly higher than average earnings of \$474 in private industry. Earnings in selected occupations in telephone communications for 2000 appear in table 2.

Table 2. Median hourly earnings of the largest occupations in telecommunications, 2000

Occupation	Telephone communications	All industries
General and operations managers	\$ 38.88	\$ 29.41
Computer software engineers, systems software	33.14	33.43
Telecommunications line installers and repairers	22.88	18.32
First-line supervisors/managers of non-retail sales workers	22.86	23.54
First-line supervisors/managers of office and administrative support workers	22.56	17.51
Telecommunications equipment installers and repairers, except line installers	22.52	21.17
Sales representatives, wholesale and manufacturing, technical and scientific products	19.09	25.30
Customer service representatives	16.58	11.83
Sales representatives, wholesale and manufacturing, except technical and scientific products	15.97	19.40
Telephone operators	14.79	13.46

About 26.7 percent of employees in the industry are union members or covered by union contracts, compared with 15 percent for all industries. Most telecommunications employees belong to one of two unions—the Communications Workers of America or the International Brotherhood of Electrical Workers.

Outlook

Employment in the telecommunications industry is expected to increase 12 percent over the 2000-10 period, somewhat less than the 15 percent projected for all industries combined. Increases in both residential and business demand for high-capacity communications will lead to the expansion of telecommunications networks. Rapidly increasing wireless demand, and the construction of a new generation of wireless systems, will contribute to the continued rapid growth of the wireless portion of the industry. However, technological improvements, such as fiber-optic lines and advanced switching equipment, have massively increased the data transmission capacity of telecommunications networks, thus limiting employment growth due to productivity gains. The best employment opportunities will be for individuals with strong technical skills.

Residential demand will increase as technology and competition lower the price of today's premium services, such as high-speed Internet access, wireless telephone service, and cable television. Demand also will increase as deregulation allows providers to offer combined services, making it easier for households to obtain a wide variety of telecommunications services. Wireless carriers will enter into the residential service business, providing fixed systems and high-speed Internet service. Therefore, the lines between cable TV, wireless, and wireline telephone systems will become blurred.

Business demand will rise as companies increasingly rely on their telecommunications systems to conduct electronic commerce. In order to remain competitive, businesses will require higher-speed access to the Internet for a variety of purposes

including purchasing, marketing, sales, and customer service. Some employment loss will result from improved labor-saving technologies, such as self-monitoring equipment, and from layoffs resulting from mergers and consolidation in the deregulated industry.

Technology will continue to transform the industry. The installation and upgrading of fiber optic networks will bring ever-faster communications closer to residential customers. Internet telephony, which transmits voice, video, fax, and electronic mail communications over the World Wide Web, will blur the boundaries between telecommunications providers and Internet service providers. Wireless providers will increase the capacity of their radio networks and introduce portable, lightweight devices capable of transmitting voice, data, and video. Undersea cables and orbiting satellites will integrate wireline and wireless customers into a global system of high bandwidth communications. The installation of computerized switching systems designed for digital content makes transmitting data, video, and graphics as easy as making voice telephone calls.

The removal of competitive barriers increased competition from providers outside the traditional telecommunications industry. Cable TV providers are using their wireline networks to offer customers a combination of services including telephone service, Internet access, and cable TV programming.

Employment growth will differ among the various occupations in the telecommunications industry, largely as a result of technology. Employment of telephone operators is expected to decline due to increasing automation. Computer voice recognition technology lessens the need for central office operators, as customers can obtain help with long distance calls from automated systems. This technology, which also enables callers to request numbers from a computer instead of a person, is expected to reduce the number of directory assistance operators. Their numbers may drop further as the increasing use of the Internet leads customers to use automated directory assistance resources on the Web.

Employment of line installers and repairers is expected to increase as telecommunications providers expand their networks in response to customer demand. New fiber optic networks will be installed and existing ones expanded to provide customers with high-speed access to data, video, and graphics. Businesses will request more wireline installations to provide increased

connections to suppliers and customers. Residential customers who are not able to obtain upgrades to their copper wirelines will install additional wirelines in order to use voice and data communications simultaneously.

Employment of telecommunications equipment installers and repairers is expected to decrease because newer, more reliable technologies will decrease the need for equipment maintenance. However, there still will be many openings available for individuals with the necessary technical skills.

Employment of engineers and computer professionals is expected to increase. The expansion of communications networks, and the need for telecommunications providers to invest in research and development, will create job opportunities for electrical and electronics engineers. The use of increasingly sophisticated computer technology will increase employment of computer professionals, including computer software engineers, computer support specialists, and computer systems analysts. Growth among these occupations will, in turn, create employment opportunities for engineering and computer and information systems managers.

Sources of Additional Information

For more details about employment opportunities, contact your local telephone company or write to:

- International Brotherhood of Electrical Workers, Telecommunications Department, 1125 15th St. NW., Washington, DC 20005.
- Communications Workers of America, 501 3rd St. NW., Washington, DC 20001. Internet: <http://www.cwa-union.org>

For more information on the telephone industry, write:

- United States Telecom Association, 1401 H St. NW., Suite 600, Washington, DC 20005-2164. Internet: <http://www.usta.org>

More information about the following occupations in the telecommunications industry appears in the 2002-03 edition of the *Occupational Outlook Handbook*.

- Communications equipment operators
- Line installers and repairers
- Office clerks, general
- Radio and telecommunications equipment installers and repairers